National Wildfire Coordinating Group

# Fire Shelter Subcommittee

## Frequently Asked Questions about Fire Shelters

**14 May 2019**

### GENERAL

**What is a fire shelter?**

The fire shelter is an aluminized cloth tent that offers protection in a wildfire entrapment situation by reflecting radiant heat and providing a volume of breathable air. Additional information can be found at the fire shelter website.

**When did firefighters begin using fire shelters?**

Wildland firefighters have carried fire shelters since their development in the 1960s. The current model has been in use by firefighters since 2003.

**Are all federal, state, and local agency firefighters required to carry a fire shelter?**

Wildland firefighters were first required to carry fire shelters as personal protective equipment in 1977. The NWCG member agencies have all required the current model since 2010.

**When should a fire shelter be used?**

Firefighters train extensively in fire entrapment avoidance, so fire shelters are used in the very rare occurrence of a fire entrapment where firefighters feel the shelter is needed for protection from heat, smoke, and/or ember showers.

**How does the fire shelter work?**

The fire shelter provides protection primarily by reflecting radiant heat and trapping breathable air inside. The current shelter is comprised of two layers. The outer layer is woven silica laminated to aluminum foil. The foil reflects radiant heat and the silica cloth slows the transfer of heat to the inside of the shelter. An inner layer is fiberglass laminated to aluminum foil. The inner layer of foil prevents heat from being reradiated inside the shelter, and it prevents gases from entering the shelter. When the two layers of materials are sewn together, the air gap between them provides additional insulation.

**What kind of training do firefighters need to use the fire shelter?**

Wildland firefighters are properly trained in the use of a fire shelter. Required annual training includes, at a minimum, reviewing the training pamphlet, viewing the fire shelter training video, and practicing deployments using a practice fire shelter. Firefighters are trained that fire shelters are not fail-safe. Additional risks should not be taken because a firefighter is carrying a fire shelter.

**Where can I find fire shelter training and videos?**

Find NWCG's The New Generation Fire Shelter, PMS 411, pamphlet and video at https://www.nwcg.gov/publications/411. Additionally, the Wildland Fire Safety and Training Annual Refresher (WFSTAR) includes several videos on fire shelters and entrapment avoidance (https://www.nwcg.gov/publications/training-courses/rt-130/wfstar-catalog).

## CURRENT DESIGN

### How was the current fire shelter developed?

The current shelter design was selected in 2002 for its improved protection from radiant and convective heat. The original shelter was designed to reflect radiant heat; however, direct flame contact could cause damage. Fatalities occurred when flame contact was severe.

Development of the current fire shelter began in 2000. A worldwide material search was conducted. Small and full-scale tests were developed to measure the strength, durability, flammability, thermal performance, and toxicity of various shelter designs and materials. The testing took place at the Protective Clothing Equipment Research Facility at the University of Alberta in Edmonton. More than 60 materials and combinations of materials were considered and 17 full-scale designs were tested. Interagency Fire and Aviation Management leadership selected the new, current shelter from four final designs in June 2002.

### What is the difference between the old and current fire shelter?

The old shelter was fiberglass material laminated to aluminum foil; the current shelter is silica cloth laminated to aluminum foil on the outside layer. The inside layer is aluminum foil laminated to fiberglass.

The current fire shelter is shaped like a half-cylinder with rounded ends. It reflects radiant heat better and has a lower profile that can withstand direct flame better than the old style. The previous version was triangular prism-shaped, similar to a small one person tent.

### How has the performance improved with the current fire shelter?

The current fire shelter significantly improved performance over prior models due to the materials, construction, and design. Additional protection from radiant heat is achieved with the utilization of two layers. Improved glue performance allows the shelter to maintain its integrity under higher temperatures. The rounded design provides better radiant heat protection than the old style. The greatest threats a firefighter faces during an entrapment situation are burns to the body and inhalation of hot gases, which can cause asphyxiation. Scientific estimates of the maximum survivable air temperature vary, but dry air temperatures as high as 300 degrees Fahrenheit are considered survivable for only very short periods of time.

### What types of heat can a fire shelter encounter?

The current fire shelter works well in radiant heat because the outside layer of aluminum foil reflects 95 percent of the radiant heat and temperatures inside the shelter rise slowly. Unlike radiant heat, convective heat from direct flame contact is more quickly conducted into the shelter, raising temperatures inside the shelter more rapidly.

### What are wildland fires temperatures?

Wildland fires are typically 1,600 degrees Fahrenheit; in some instances, temperatures can reach 2,000 degrees Fahrenheit. The most extreme temperature measured on a wildland fire was 2,400 degrees Fahrenheit.

### What is considered a survivable temperature for humans?

A tenable condition for an extended period for humans is about 250 degrees Fahrenheit. Humans can survive up to 300 degrees Fahrenheit for a short period of time.

### Have the fire shelter been field tested?

The current fire shelter has been tested and shown survivable temperatures in typical exposures of 1,700 degrees Fahrenheit with some flame contact.

### Who makes the fire shelter?

A contractor for Defense Logistics Agency (DLA) manufactures the shelters according to U.S. Forest Service specifications. The specifications include the exact materials to use, as well as the shelter patterns and construction details. DLA administers the contract. To ensure quality assurance and quality control, the contractor is regularly inspected by the U.S. Forest Service and Underwriter's Laboratory (UL).

## FIRE SHELTER REVIEW PROJECT

### What prompted the fire shelter design review?

The USDA Forest Service initiated the Fire Shelter Project Review in 2014. Research was conducted by the National Technology and Development Program (NTDP), in coordination with the NWCG Fire Shelter Subcommittee (FSSC), to identify possible improvements to the fire shelter system wildland firefighters carry.

### What is the Fire Shelter Subcommittee?

The NWCG FSSC is comprised of federal, state, and local wildland firefighters. Their mission is to provide interagency leadership and oversight in all areas of the fire shelter program. (https://www.nwcg.gov/committees/fire-shelter-subcommittee) The FSSC works under the direction of the NWCG Equipment and Technology Committee (ETC). (https://www.nwcg.gov/committees/equipment-technology-committee)

### What types of shelter materials were submitted and researched?

NTDP executed an exhaustive search of materials and designs, working with 23 different entities, which produced hundreds of different materials and combinations of materials. The fire shelter material search was divided into three categories:

- Lighter weight and less bulk with similar performance to the current shelter.
- Similar weight and bulk with improved performance.
- Heavier weight and bulk with pronounced improved performance.

### How were the materials and designs evaluated?

The materials and designs were evaluated on weight, bulk, durability, and toxicity that are critical to determine suitability for use in fire shelters. Suitable materials were tested in a small-scale flame test to determine material strength, durability, flammability, and thermal performance. Materials that showed promise in the small-scale test were then constructed into fire shelters and tested in a full-scale, direct flame test to measure the performance of the overall fire shelter design.

After hundreds of full-scale lab tests, four prototype designs were selected for wear testing by firefighters during the 2018 fire season. A total of 60 prototype shelters were produced for wear testing to expose any unforeseen issues with production, packaging wearing, and durability.

**What fire shelter material testing has occurred since project initiation?**

The Fire Shelter Test Protocol was the basis for testing material samples. Promising materials were used to construct full-scale fire shelters. Shelters were tested in crown fire testing in the Northwest Territories of Canada, as well as lab testing at the University of Alberta during 2015 through 2017. Promising materials were made into prototype shelters and wear tested in 2018.

**What is the difference between the four fire shelter prototypes?**

One of the prototypes that was lighter, smaller, and performed better than the current shelter, did not satisfactorily endure production rigors and was eliminated from consideration. One prototype style was tested by line-going firefighters and 20 of each were issued to Interagency Hotshot Crew firefighters for wear testing. Then each of the two large, bulkier shelters were carried by engine and equipment operators only. NASA and the U.S. Forest Service have a cooperative work agreement for this project and two of the prototype fire shelters are NASA designs.

**What were the results of the wear testing?**

The prototype designed for line-going firefighters showed a 37-second direct-flame test performance improvement, however it is nearly one pound heavier and has 1.7 times more volume than the current shelter. The prototype designed for equipment operators was more than four times the volume and nearly 1½ pounds heavier.

**What criteria did the Fire Shelter Subcommittee (FSSC) consider after the wear testing results?**

The FSSC weighed many facets of the fire shelter but emphasized the increased physiological stress of the additional weight, limited storage space left in firefighters' packs, the limited incremental increase in protection, the firefighter survey showing a desire for a lighter weight/less bulky shelter, and the trend toward decreased number of annual fire shelter deployments.

**How did NASA participate in the fire shelter review?**

The U.S. Forest Service entered into a collaborative agreement with the NASA Langley Research Center, located in Hampton, Virginia, to examine potential improvements to fire shelter performance. A team of engineers from NASA is developing flexible heat shields that will protect spacecraft from the high temperatures of atmospheric entry under NASA's Hypersonic Inflatable Aerodynamic Decelerator (HIAD) project. NASA and the U.S. Forest Service have found common performance requirements between fire shelters and flexible heat shields that can benefit both organizations.

North Carolina State University Wilson College of Textiles, which received a grant under the Assistance to Firefighter Program of FEMA, also submitted fire shelter prototypes that were considered by the FSSC. Its shelter submissions closely mirrored the NASA prototypes.

**What was the outcome?**

The five-year study concluded the current fire shelter model continues to provide the most practical amount of protection given tradeoffs of weight, volume (bulk), durability, and material toxicity. There will be slight changes to the 1) pattern design to use material more efficiently, 2) adhesive formula which increases the degradation temperature and is less soluble in water and, 3) the fire shelter's polyvinyl chloride (PVC) bag to ensure a more reliable opening.